Current tracking issues

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Push for more realistic tracking - 1

Having settled on a tracker layout (3 MAPS silicon pixel layers, 4 INTT silicon strip layers, TPC), over the last 6 months or so we have been trying to improve the accuracy/realism of the tracking simulation.

Our default tracking model prior to these improvement attempts was:

3 MAPS pixel layers
    0.3% X/X_0 per layer, cylinder cell geometry
4 INTT strip layers
    1% X/X_0 per layer, cylinder cell geometry
TPC
    60 layers, different gas from what we decided to use

We have kept this stable while being semi-continuously reviewed!

Push for more realistic tracking - 2

First: Replace the cylinder cell models of the silicon detectors in G4 with realistic models of the ladders.

MAPS: Import the ALICE ITS inner barrel staves into our simulation without modification, construct three inner barrel layers from them. Done.
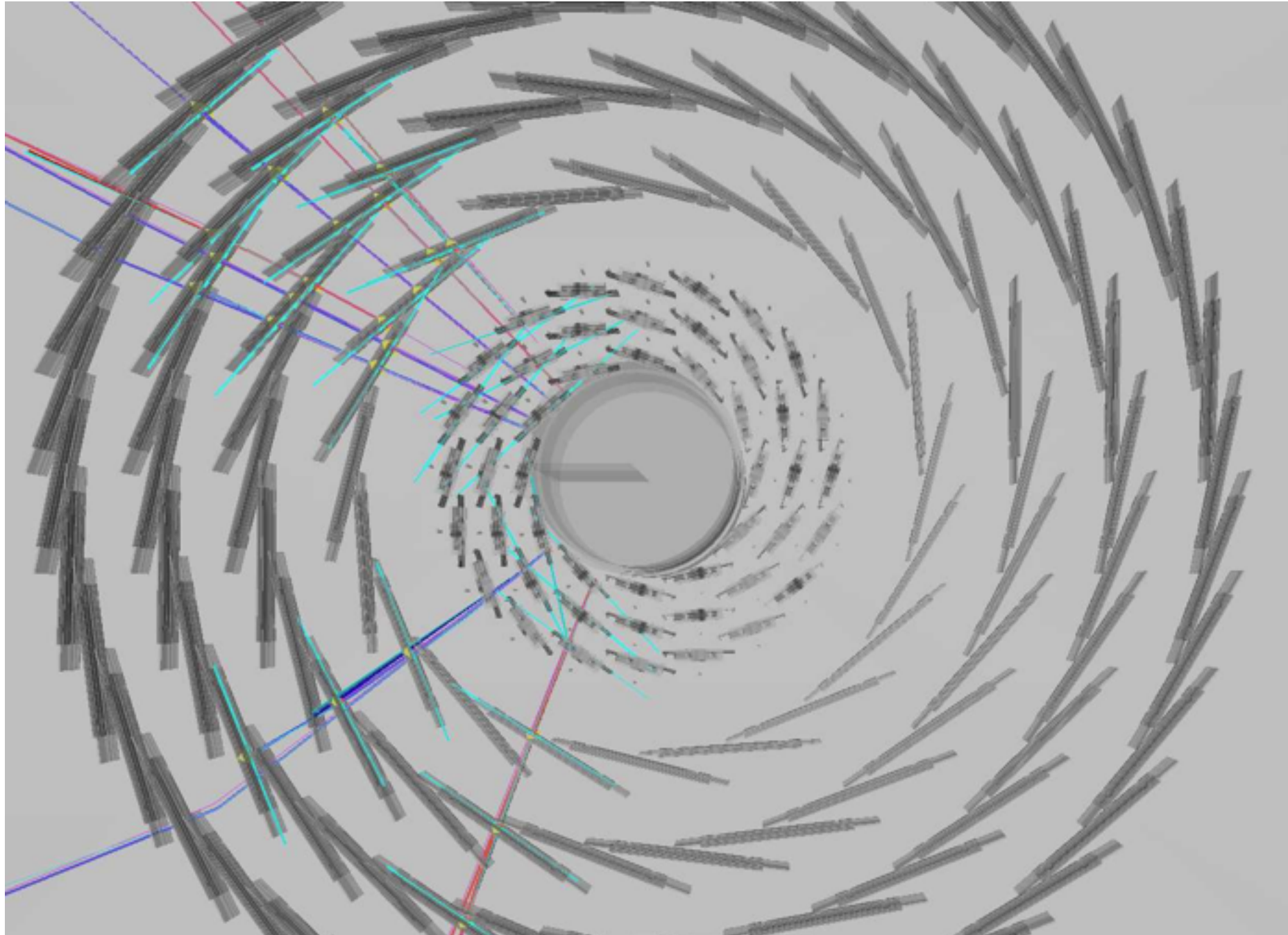
INTT: Create a ladder model of the four silicon strip layers in G4 (Gaku Mitsuka). Done.

Second: Make the TPC simulation closer to what is currently planned. This work is ongoing.
• Decrease the number of readout layers to 40 from 60.
• Change to a new pad readout configuration.
• Change to the gas that we now plan to use.

Ladder models of the silicon

Results - 1

We have now had a chance to look at the ladder models. We find (from a material scan in G4):

MAPS: The ladder model has very similar thickness to our assumed cylinder cell model thickness - about 1% X/X_0 for 3 layers combined.

INTT: The ladder model is much thicker than our assumed cylinder cell model thickness - about 1.85% X/X_0 per layer, or 7.6% for 4 layers combined.
• This comes about because the ladders have to be overlapped by a factor of 2 to get 25% azimuthal sensor overlap.

With our current tracking model, the thickness of the INTT pushes our Upsilon resolution well over our specification of < 100 MeV.

Results - 2

The changes to the TPC model are still being worked on, but some differences from our previous default tracking model are clear:

- The active outer radius moves in from 78 cm to 75 cm.
- The number of readout planes drops from 60 to 40.
- The gas drift and diffusion parameters change, which will affect the space point resolution - still being evaluated.

The TPC group is still working on determining how these changes should be put into the simulation.

Where do we go from here? - 1

In the tracking meeting this morning we had a presentation from Itaru Nakagawa on behalf of the RIKEN group.

Itaru discussed the mass budget of the INTT:
• The overlap of the ladders can not be reduced much
• He described several ongoing or planned R&D efforts that might reduce the mass budget by as much as 40%.

The RIKEN group is also looking into whether an improved tracking algorithm can reduce the impact of the INTT mass on the Upsilon mass resolution.

And, of course, there remains the option of reducing the number of INTT layers below 4 if all else fails.
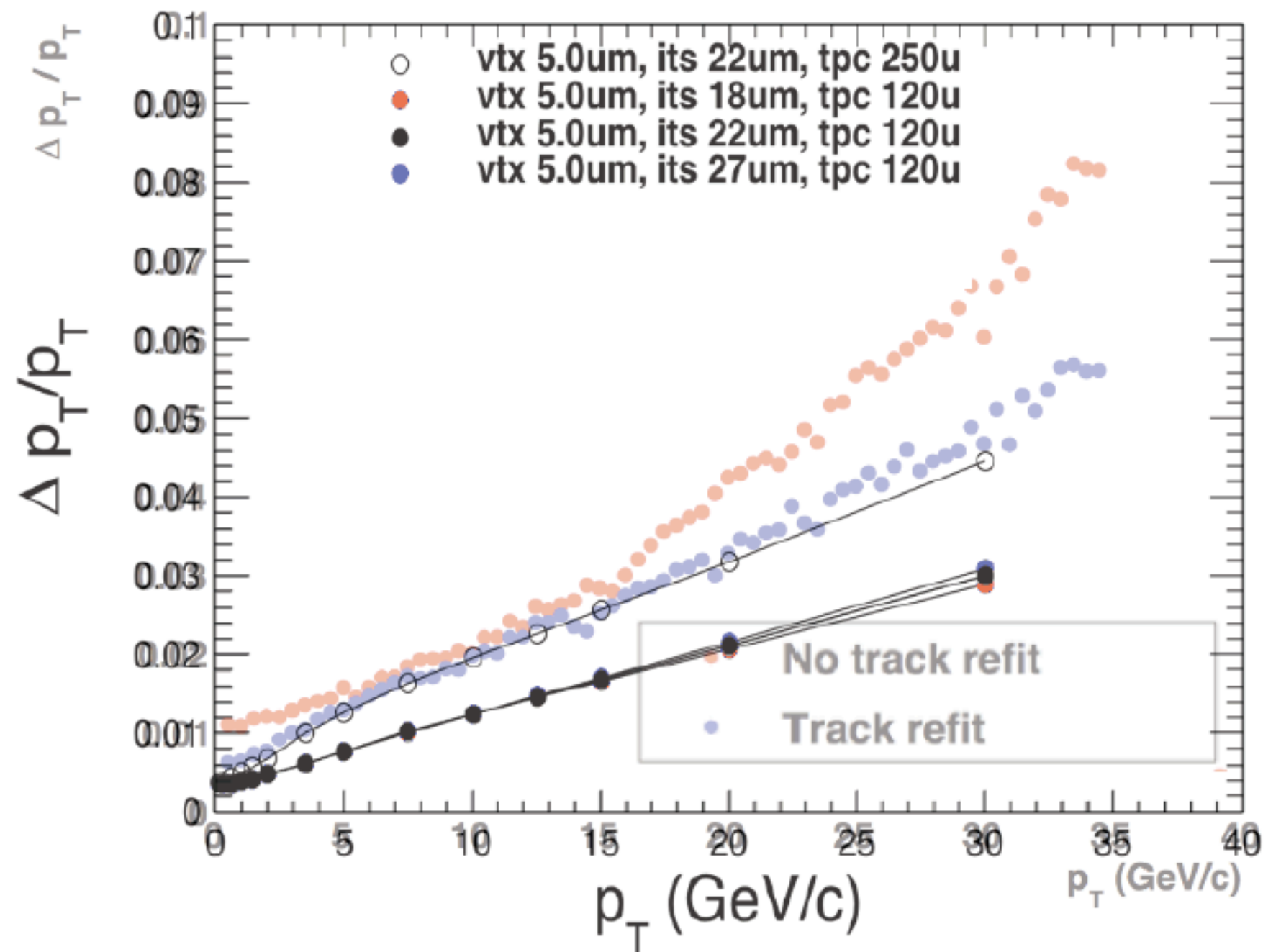
Where do we go from here? - 2

In the tracking meeting this morning we also had a presentation from Christof Roland of MIT, who has recently joined our tracking effort.

Christof showed some results from a toy model developed for the LiC that is useful at CERN to evaluate tracker designs. It incorporates multiple scattering, and uses a Kalman filter to track. He showed a comparison with full sims from the ALICE LOI, the STAR HF tracker - looks pretty reasonable.
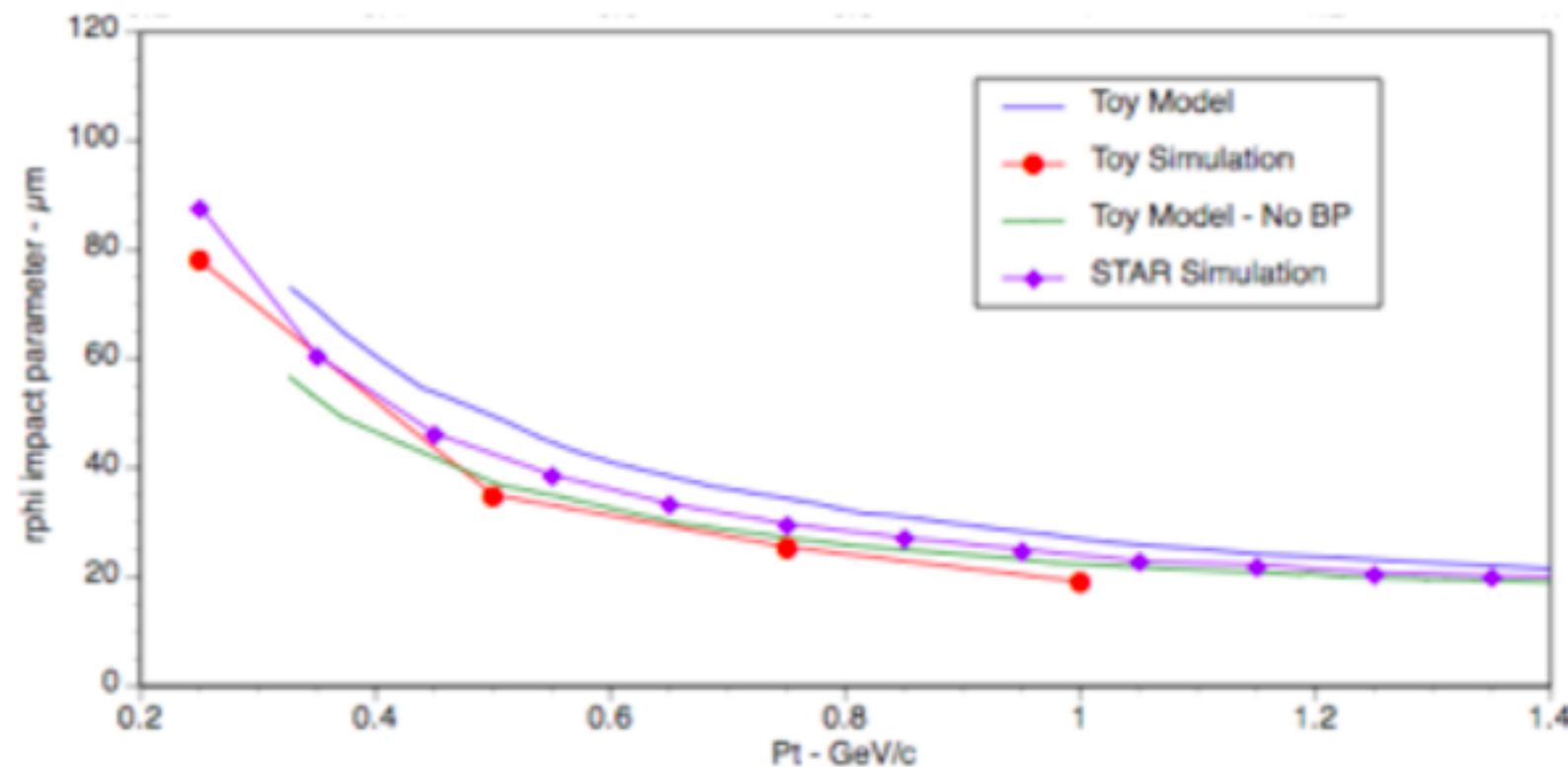
Where do we go from here? - 3

PowerPoint overlay of toy model (including material budget corresponding to our full ladder models) results with our full simulations - provides some indication that we may have room for improvement
without reducing
the mass.

Where do we go from here? - 4

Another issue that we will definitely have to address is the track reconstruction time. For a central Au+Au event, we presently need of order 1 hour. We will need more like a few seconds.

Chris has looked at this and made some improvements, but says he does not see any quantum leaps with the present code.

Christof says that track reconstruction times in CMS are much faster. It is likely that we will adapt some version of the tracking used by LHC experiments, so this may take care of itself.